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VARIATION IN *PEROMYSCUS MANICULATUS OSGOODI* FROM THE UINTA MOUNTAINS, UTAH*

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THE present work was undertaken to determine the differences in the characters of the deer mouse (*Peromyscus maniculatus osgoodi*) in three life belts on the northern slope of the Uinta Mountains, Utah.

I am grateful to the Museum of Zoology, University of Michigan, for the use of specimens and other facilities; to Frederick M. Gaige, Director of the Museum, for support and encouragement; and to Lee R. Dice for criticism and advice. The William P. Harris, Jr., Fellowship and the Edwin C. Hinsdale Fellowship, granted to me in 1932–33 and 1933–34, respectively, have made the work possible.

MATERIAL

The stocks of mice which were used in this study were collected by Ruth and Arthur Svihla on the northern slope of the Uinta Mountains and on the adjacent plain. They were taken at three localities, Linwood, Sheep Creek, and Summit Springs, in Daggett County, Utah. The Uinta Mountains lie in the northeastern corner of Utah, and rise abruptly from the plain (R. Svihla, 1932: 51–52). Four vegetation belts are represented in a transect from the plain to the summit of the mountains. These belts are sagebrush, pine, spruce fir, and alpine (Fig. 1).

The Linwood stock was collected in the north central part of Daggett County, along Henry's Fork, about one-fourth mile north of Linwood, at an altitude of 6,000 feet. This station is in typical sagebrush country. Two females and two males, which were secured from this locality, gave rise in the laboratory to two lines of offspring, one noninbred and one inbred. The noninbred line produced 103 offspring which averaged 51.8 (39–78) weeks of age at the time they were killed. The inbred line, descended from one pair of mice, produced 21 offspring which averaged 41.5 (37–78) weeks at the time they were killed. A total of 124 specimens of the one-year age class was therefore available for study. The average age of the whole lot when killed was 50.0 (37–78) weeks.

The Sheep Creek stock was taken eight miles south of Linwood at an altitude of 6,000 feet. Sheep Creek is at the foot of the Uinta Mountains. In the bottom of the canyon where the mice were trapped there is a considerable growth of juniper, pine, fir, poplar, willow, and birch. Two pregnant females from Sheep Creek gave birth to young in the laboratory. These two females, two other females, and two males became the parents of the stock, and gave rise to two lines of offspring, one noninbred and two inbred. The noninbred line produced 45 offspring, killed at an average age of 52.0 (36–78) weeks. The inbred line, which originated from a single pair of field-caught mice, produced 40 offspring, averaging 43.6 (37–76) weeks of age at the time they were killed. A total of 85 specimens of the one-year age class was available for study. The average age of the whole stock, when killed, was 48.0 (36–78) weeks.

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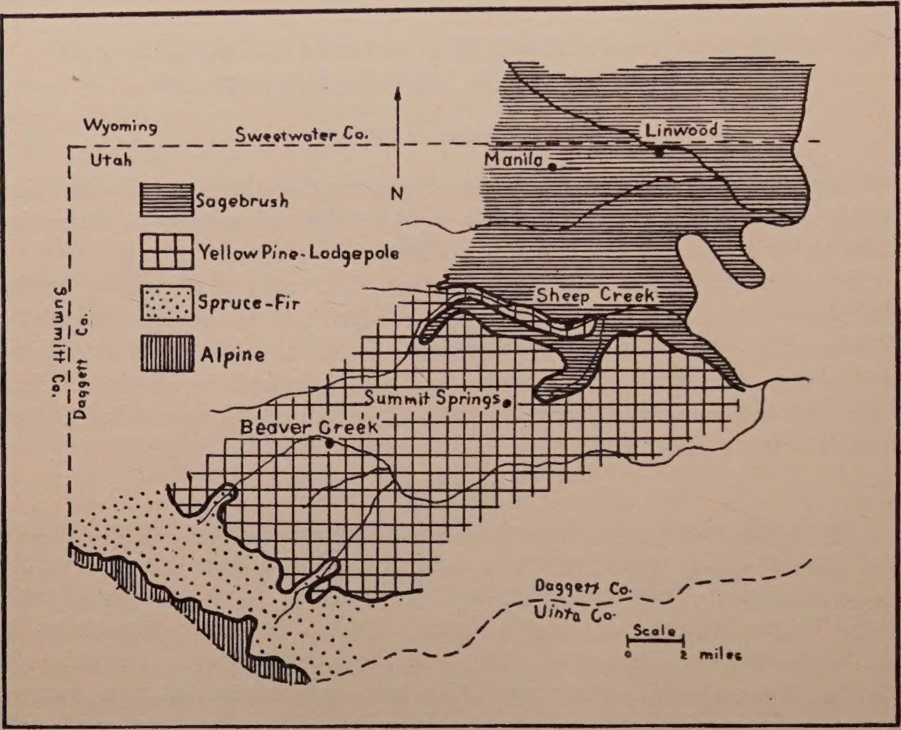

FIG. 1. Sketch map of parts of Daggett County, Utah, and Sweetwater County, Wyoming, showing vegetation belts and collecting stations (after Svihla).

The Summit Springs stock was taken at an elevation of 8,000 feet, five miles up the mountain from Sheep Creek. Summit Springs is in open, yellow pine country, where sagebrush forms a sparse undergrowth. One female and three males became the parents of the stock. A total of 102 specimens of the one-year age class was available for this study. The mice averaged 49.4 (36–76) weeks of age at the time they were killed, with the exception of one mouse which was 34 weeks old. This young specimen was fully as large as the average of the stock. There was considerable inbreeding, as all the laboratory-bred mice were descended from the one female.

All the breeding stocks of *Peromyscus* were collected in the summers of 1928 and 1929, and the offspring were reared at the Museum of Zoology, University of Michigan, under the laboratory conditions described by Dice (1929: 116–24).

The body measurements of the mice were taken by Lee R. Dice. I took the skeletal measurements and the tint photometer readings. The method of taking the several measurements of the body and skeleton has been described by Dice (1932: 6–7). The probable errors of the means, rather than standard errors, are given in this paper.

VARIATION WITHIN THE STOCKS

Undoubtedly every population of wild *Peromyscus* possesses a certain amount of genetic variability; different individuals possess different hereditary characters. One pair of mice should, therefore, produce offspring having somewhat different average characters from those of the offspring produced by any other pair, and the amount of divergence of an inbred line from the average of the population should indicate something of the amount of diversity of hereditary factors in the population.

A considerable amount of variability in hereditary characters has been shown to occur within a single population of *Peromyscus maniculatus rufinus* (Dice, 1933: 18–28). Similar variations in hereditary characters are here shown to be present in two populations of mice from the Uinta Mountains.

Two lines of inbred mice, one from Linwood and one from Sheep Creek, were raised in the laboratory and are here compared with the noninbred lines from the same localities (Table I). In both stocks the noninbred lines average eight to ten weeks older than the inbred lines, and this difference no doubt causes part of the difference in average size; but there is very little growth in the deer mouse between the ages of forty to fifty weeks (Murie and Bradley, MS.), so the age difference is believed not to be sufficient to explain all of the differences in measurements between the inbred and the noninbred lines.

The inbred compared with the noninbred Linwood mice are shown by Table I to average 2.25 ± 0.56 mm. shorter in body length, a difference 4.0 times its probable error; 5.36 ± 0.44 mm. shorter in tail length, a difference 12.2 times its probable error; and 0.58 ± 0.09 mm. smaller in ear length, which is 6.5 times the probable error. The differences in tail length and ear length are certainly significant, but the importance of the difference in body length is questionable.

In the Sheep Creek stock the inbred mice as compared with the noninbred mice average 2.19 ± 0.62 mm. shorter in body length, a difference of 3.5 times the probable error; 3.33 ± 0.58 mm. shorter in tail length, a differ-

TABLE I

MEASUREMENTS OF INBRED AND NONINBRED LINES OF *PEROMYSCUS MANICULATUS OSGOODI* FROM THE UINTA MOUNTAINS, UTAH

1-year age class; ♀ + ♂, except for foot length; means and probable errors, in millimeters

Stock	No.	Body Length	Tail Length	♀ Hind Foot	♂ Hind Foot	Ear
Linwood (noninbred)	103	91.35 ± .28	68.55 ± .28	19.874 ± .064	20.088 ± .046	18.372 ± .038
Linwood (inbred)	21	89.10 ± .48	63.19 ± .34	....	....	17.795 ± .080
Sheep Creek (noninbred)	45	90.47 ± .41	71.51 ± .40	20.200 ± .070	20.490 ± .064	18.909 ± .100
Sheep Creek (inbred)	40	88.28 ± .47	68.18 ± .42	20.083 ± .088	20.159 ± .047	18.638 ± .081
		Femur	Mandible	Condyle-premaxilla	Condyle-zygoma	Bullar Width
Linwood (noninbred)	103	15.755 ± .035	15.857 ± .031	24.120 ± .042	17.153 ± .029	10.888 ± .014
Linwood (inbred)	20	15.432 ± .095	15.185 ± .061	23.380 ± .078	16.785 ± .058	10.660 ± .037
Sheep Creek (noninbred)	42	16.026 ± .071	16.032 ± .048	24.460 ± .069	17.362 ± .048	10.810 ± .022
Sheep Creek (inbred)	39	15.649 ± .061	15.751 ± .040	24.116 ± .075	17.182 ± .049	10.618 ± .056

ence of 5.7 times the probable error; and 0.33 ± 0.08 mm. smaller in foot length (males only), a difference 4.2 times the probable error. The difference in ear length between the two lines is slight. The differences in body length and foot length between the two lines are not of much importance when one considers the diversity in age, but the difference in tail length is probably significant.

In the Linwood stock the inbred strain averages smaller than the noninbred mice in every skeletal measurement. The differences are significant, being from 5.7 to 9.9 times their probable errors, except for femur length, which does not differ significantly.

In the Sheep Creek stock the inbred strain also averages smaller in all skeletal measurements than it does in the noninbred mice, but the differences are of doubtful significance.

The tint photometer readings of pelage color, both for the dorsal stripe and for the side, of the inbred strains average lower than those of the noninbred strains, but the differences are not of statistical significance.

The consistently greater size, for all measurements, of the two noninbred strains over the inbred strains may in part result from the age differences between the strains. However, the shorter tail, smaller ear, and lesser skeletal measurements of the inbred Linwood mice, and the shorter tail of the inbred Sheep Creek mice are statistically significant, and age alone cannot account for differences as great as these.

COMPARISON OF THE STOCKS

Dimensions

In body length the Summit Springs mice are the largest of the three Uinta Mountains stocks (Table II), averaging 3.48 ± 0.39 mm. longer in this measurement than the Linwood mice, and 5.00 ± 0.45 mm. longer than the Sheep Creek mice. These differences are, respectively, 8.9 and 11.2 times the probable error. The Linwood mice average 1.52 ± 0.40 mm. more in body length than the Sheep Creek mice. This difference is 3.8 times the probable error, and is doubtfully significant. It should be noted that the mice from Summit Springs, the station farthest up the mountain slope, have the greatest body length. The mice from Sheep Creek, the station at the foot of the mountain and between the other two stations, have the smallest body length, and those from Linwood, the station in the sagebrush country, are not greatly different in body length from the Sheep Creek mice.

In tail length the Sheep Creek mice average the longest of the three stocks. Their tails average 2.36 ± 0.41 mm. longer than those of the Linwood mice, and 3.82 ± 0.42 mm. longer than those of the Summit Springs mice. These differences are respectively, 5.7 and 9.0 times their probable errors. The Linwood mice average 1.46 ± 0.40 mm. longer in tail length than the Summit Springs mice, a difference which is 3.7 times its probable error, and not certainly significant. Of the three stocks, the Summit Springs

TABLE II

Measurements of *Peromyscus maniculatus osgoodi* from the Uinta Mountains, Utah
1-year age class; ♀ + ♂, except for foot length; means and probable errors, in millimeters

Stock	No.	Body Length	Tail Length	♀ Hind Foot	♂ Hind Foot	Ear
Linwood	124	90.97 ± .24	67.59 ± .27	19.862 ± .058	20.085 ± .042	18.274 ± .037
Sheep Creek	85	89.45 ± .32	69.95 ± .31	20.151 ± .055	20.317 ± .040	18.781 ± .066
Summit Springs	103	94.45 ± .31	66.13 ± .29	19.908 ± .048	20.213 ± .065	16.890 ± .054
		Femur	Mandible	Condyle-premaxilla	Condyle-zygoma	Bullar Width
Linwood	123	15.705 ± .034	15.747 ± .032	24.000 ± .041	17.093 ± .027	10.851 ± .015
Sheep Creek	81	15.844 ± .049	15.895 ± .033	24.296 ± .052	17.276 ± .036	10.717 ± .018
Summit Springs	100	16.041 ± .039	15.750 ± .027	23.949 ± .040	17.229 ± .028	10.724 ± .018

mice have the shortest tails, the Sheep Creek mice, the longest tails, and the Linwood mice have tails which in length average close to the Summit Springs mice.

The hind foot of the Sheep Creek mice averages longer than that of either of the other two stocks. The average foot length in the females is 0.289 ± 0.080 mm. greater than that of the Linwood females, and the males average 0.232 ± 0.058 mm. greater than the Linwood males. The differences are, respectively, 3.6 and 4.0 times their probable errors and are of doubtful significance. The foot length of the Sheep Creek females compared with the same measurement in the Summit Springs females averages 0.243 ± 0.073 mm. greater. In the males it averages 0.104 ± 0.076 mm. greater than in the Summit Springs males. These differences are, respectively, 3.3 and 1.4 times their probable errors and are of no statistical significance. The Linwood mice and Summit Springs mice do not differ significantly in this measurement.

In hind foot length the males of each stock average longer than the females of the same stock. The same sexual difference has been pointed out by Sumner (1924: 492), Dice (1932: 14; and 1933: 7), and Murie (1933: 11).

The ear length of the Sheep Creek mice is greater than that of either of the other two stocks. The ears of the Sheep Creek mice average 0.507 ± 0.076 mm. longer than those of the Linwood mice, and 1.891 ± 0.086 mm. longer than the ears of the Summit Springs mice. The differences are 6.7 and 22.1, respectively, times their probable errors. The ears of the Linwood mice are 1.384 ± 0.066 mm. longer than the ears of the Summit Springs mice, the difference being 21.1 times its probable error. The Summit Springs mice have the smallest ears, the Sheep Creek mice the largest ears, and the Linwood mice have ears intermediate in size.

The femurs of the Summit Springs mice are the longest of the three stocks, averaging 0.336 ± 0.051 mm. longer than the Linwood mice, or 6.6 times the probable error of the difference. The femurs average 0.197 ± 0.062 mm. longer than those of the Sheep Creek mice, a difference which is 3.2 times its probable error, and doubtfully significant. The Linwood mice average slightly larger in this measurement than the Sheep Creek mice, but the difference is not significant.

In the length of the mandible the Sheep Creek mice average 0.148 ± 0.046 mm. longer than the Linwood mice and 0.145 ± 0.043 mm. longer than the Summit Springs mice. These differences are, respectively, 3.2 and 3.4 times their probable errors and are of doubtful significance. The Linwood and Summit Springs stocks differ little in this measurement.

The condylo-premaxillary skull length of the Sheep Creek mice is again greatest of the three stocks, averaging 0.296 ± 0.067 mm. more than in the Linwood mice and 0.347 ± 0.066 mm. greater than in the Summit Springs mice. These differences are, respectively, 4.5 and 5.3 times their probable errors and therefore significant. The Linwood and Summit Springs stocks do not differ greatly in skull length.

The Sheep Creek mice exceed the other groups in average length of the skull from condyle to zygoma. Their skulls average 0.183 ± 0.045 mm. longer than those of the Linwood mice, a difference 4.06 times its probable error and possibly significant. The Sheep Creek and Summit Springs mice differ only slightly in this respect. The Summit Springs mice average 0.136 ± 0.039 mm. greater than the Linwood mice, a difference 3.5 times its probable error, and doubtfully significant.

The bullar width is greatest in the Linwood stock, averaging 0.134 ± 0.023 mm. more than in the Sheep Creek stock and 1.27 ± 0.023 mm. more than in the Summit Springs stock. The differences are, respectively, 5.8 and 5.6 times their probable errors and are significant. The Sheep Creek and Summit Springs mice do not show a significant difference in this measurement.

There is apparently no geographical trend in the body measurements of the three stocks of mice from the Uinta Mountains. The Summit Springs mice average greatest for body length but shortest in length of tail and ear. The Sheep Creek mice have the shortest average body length, but the longest average measurements for tail, foot, and ear. The Linwood mice are intermediate in all measurements except foot length, in which measurement they do not differ significantly from the Summit Springs mice.

There is no apparent geographical trend in the skeletal measurements of these mice, since each stock averages greater than the others for some measurement, intermediate for some measurement, and shortest for some measurement. The differences in skeletal measurements between the stocks, however, are small, and for the most part are not of statistical importance. The Summit Springs mice average longest of the three stocks in femur length, but in the condylo-premaxillary length they average shortest. The Linwood mice average largest of the three stocks for bullar width, but shortest for femur length, mandibular length, and condylo-zygomatic length. The Sheep Creek mice average longest of the three stocks for mandibular length, condylo-premaxillary length, and condylo-zygomatic length, but are smallest for bullar width.

PELAGE COLOR

The pelage color of the flat skins was determined by means of the Ives-Hess tint photometer, after the method described by Dice (1932: 19).

The color of the dorsal stripe of the Linwood mice averages paler than that of the Sheep Creek mice. This is shown by higher readings for all the colors (Table III, and Fig. 2). The difference can easily be seen with the eye when one compares the series of skins from the two localities. The tint photometer readings for the Sheep Creek mice average, for the several color screens, from 0.72 to 1.10 units less than those for the Linwood mice. The differences in the readings are statistically significant, all being from 5.4 to 7.9 times their probable errors. These differences indicate a difference in intensity, but scarcely any difference in hue.

TABLE III

Pelage color of *Peromyscus maniculatus osgoodi* from the Uinta Mountains, Utah

1-year age class; ♀ + ♂; means and probable errors of tint photometer readings, in per cent.

Dorsal Stripe	No.	Red	Yellow	Green	Peacock Blue	Blue-violet
Linwood	122	14.67 ± .16	12.38 ± .12	9.85 ± .09	8.55 ± .07	7.50 ± .07
Sheep Creek	85	13.57 ± .14	11.49 ± .11	8.97 ± .09	7.82 ± .08	6.72 ± .07
Summit Springs	101	12.89 ± .13	11.40 ± .11	9.55 ± .09	8.57 ± .08	7.62 ± .08
Side						
Linwood	122	24.98 ± .21	21.65 ± .17	16.69 ± .14	14.27 ± .13	12.54 ± .11
Sheep Creek	85	22.70 ± .18	19.41 ± .16	14.72 ± .13	12.47 ± .13	10.59 ± .12
Summit Springs	101	22.58 ± .16	20.09 ± .14	16.02 ± .11	14.05 ± .10	12.19 + .09

The color of the dorsal stripe of the Summit Springs mice differs from that of the Linwood mice in being duller and slightly darker. The difference between the two stocks in the readings for red is 1.78 ± 0.20 tint photometer units, which is 8.7 times the probable error. For yellow the difference in readings for these two stocks is a little less, being 0.98 ± 0.16 units, which is 6.0 times its probable error, but for the green, peacock blue, and blue-violet, the difference in readings between the two stocks is not significant. The Linwood mice appear, to the eye, to be more buffy and lighter than the Summit Springs mice.

Compared to the Sheep Creek mice the Summit Springs mice differ in the hue of the dorsal stripe, this being less buffy and more grayish. The Sheep Creek mice have higher tint photometer readings for red than the Summit Springs mice, the difference being 0.68 ± 0.19 tint photometer units, which is 3.7 times its probable error, and doubtfully significant. The readings for yellow are not significantly different in the two stocks. The Summit Springs mice have the higher readings for green, peacock blue, and blue-violet, these differences being 4.7, 6.3, and 8.5 times their probable errors, respectively. It is shown therefore that the dorsal stripes of the Sheep Creek and of the Summit Springs mice differ in hue, but are of about the same general intensity of color.

The color of the side of these mice follows the same trend as that of the dorsal stripe (Table III). The tint photometer readings for the side of the Linwood mice, for the several color screens, average from 1.80 to 2.28 units higher than those for the Sheep Creek mice. These differences are significant, statistically, being from 8.2 to 11.9 times their probable errors, and indicate a difference in the intensity of color of the side for the two stocks, but practically no difference in hue.

The Summit Springs mice have lower average readings for all the colors of the side than do the Linwood mice. There is, in addition, a difference in hue similar to that in the dorsal stripe. In the tint photometer readings for red the difference between the two stocks is 2.39 ± 0.27 units, a difference 9.0 times its probable error. For yellow the difference is not quite as great, being 1.56 ± 0.22, a difference 7.2 times its probable error. For green the difference is smaller, being 0.67 ± 0.18, which is 3.7 times its probable error, and doubtfully significant. For peacock blue and blue-violet the differences are not of statistical importance. It is also apparent to the eye that the sides of the Linwood mice are more buffy and lighter than the sides of the Summit Springs mice, the latter being more grayish.

The sides of the Summit Springs mice are noticeably more grayish and less buffy in hue than are the sides of the Sheep Creek mice. The average tint photometer readings of the side for red and for yellow do not differ significantly between the two stocks. For green, peacock blue, and blue-violet the readings for the Summit Springs stocks average significantly the greater. The difference is greatest in the blue-violet, and, for the several colors, the differences are from 7.4 to 10.8 times their probable errors.

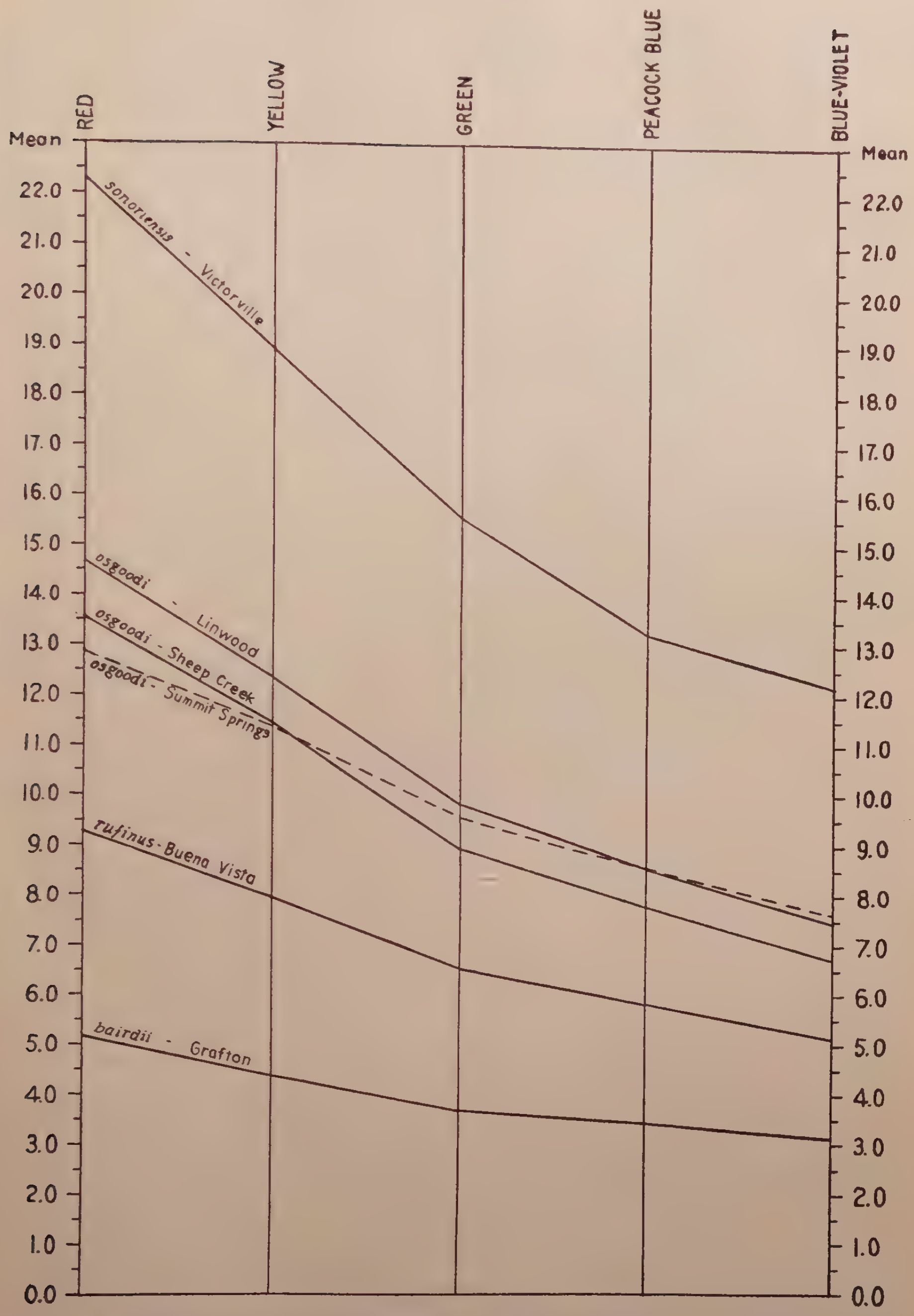

FIG. 2. Pelage color of the dorsal stripe in several subspecies of *Peromyscus maniculatus*. Mean tint photometer readings.

The pelage color, both of the dorsal stripe and of the side, of the Linwood mice, therefore, averages lighter than that of the Sheep Creek mice. The Summit Springs mice are of a different hue from the other two stocks, being less buffy and more grayish. In color intensity the Summit Springs mice average about the same as the Sheep Creek mice, but are somewhat darker than the Linwood mice.

DISCUSSION

The breeding stocks used in this study were not as large as might be wished. Consequently, considerable inbreeding occurred in all the stocks. Nevertheless, the breeding stocks are believed to have been sufficiently large so that their offspring give reliable information about the characters of their respective populations.

In some of the body measurements the three Uinta Mountains stocks of mice differ significantly from one another, but there seems to be no correlation between these differences and any known factor in the environment. The Summit Springs mice, from the most forested and humid type of habitat, average largest for body size, but shortest for tail and smallest for ear length. The Sheep Creek mice, from the foot of the mountains, in a less forested type of habitat, average smallest for body size, but largest for tail, foot, and ear. The Linwood mice, from the sagebrush plain, average intermediate for all measurements except foot length, in which they average only a trifle smaller than the Summit Springs mice. Neither is there any apparent correlation between vegetation belts and skeletal dimensions. Whether or not the differences in body size and size of extremities have any adaptive value to these mice is an open question, and further critical study of this problem is needed before any conclusions can be drawn.

The Uinta Mountains stocks of deer mice do show a correlation between pelage color and vegetation belt. The Linwood mice, from the sagebrush plain, are palest in color of the three stocks. The Sheep Creek mice, from the partly wooded canyon at the foot of the Uinta Mountains, are slightly darker in color than the Linwood mice, and the Summit Springs mice, from the open yellow pine country 2,000 feet farther up the mountain side, are darkest of the three stocks and are more grayish.

Field collections of *osgoodi* from this general region show the same correlation between pelage color and vegetation belts as do the laboratory-reared specimens. There are available field-collected specimens from three stations in the Uinta Mountains and vicinity. These collections consist of forty-two adult specimens, which have been prepared as round skins, and are now in the Museum of Zoology, University of Michigan. Twelve specimens, taken by Ruth and Arthur Svihla in July, 1928, are from Sheep Creek, at the location already described; nine specimens, taken by the Svihlas in July, 1928, are from Beaver Creek (Fig. 1), fourteen miles up the slope of the mountain from Sheep Creek, and well within the pine belt; and twenty-one specimens, taken by Adolph Murie in July, 1932, are from near the middle of Sweetwater County, Wyoming, and well within the sagebrush belt.

The mice from Sweetwater County average considerably paler in color than the mice from the other two stations. The mice from Sheep Creek average intermediate in color between the Sweetwater County mice and the Beaver Creek mice. Those from Beaver Creek average distinctly darker than the Sheep Creek and Sweetwater County mice. The characters present in these field-collected mice corroborate the evidence from the laboratory mice in showing that, in this region, mice from the sagebrush belt are palest while those from the pine belt are darkest.

SUMMARY

Breeding stocks of *Peromyscus maniculatus osgoodi* were available from Linwood, Sheep Creek, and Summit Springs, which are three localities in different vegetation belts on the north slope of the Uinta Mountains, Utah, and on the adjacent sagebrush plain. These parent stocks produced 312 offspring, which were prepared as specimens in the laboratories of the University of Michigan, all in the spring of the year, and at ages averaging about one year.

In inbred lines from Linwood and Sheep Creek, some of the body dimensions average significantly smaller than in noninbred lines from the same localities.

There is apparently no correlation between the dimensions of the body or skeleton and the vegetation belts on the slopes of the mountains.

There is, on the contrary, a general correlation between the pelage color of the mice from the three stations on the Uinta Mountains and the vegetation belts which they inhabit. The mice from the Linwood station, in the arid sagebrush belt, are the lightest colored of the three stocks. The mice from the Sheep Creek station, along a creek at the upper part of the sagebrush belt, are darker than those from Linwood. The mice from Summit Springs, in the pine belt, average darker and grayer than the Linwood mice and are more grayish than the mice from Sheep Creek.

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